SCIENTIFIC BALLOONING.

THE exploration of the upper air has become increasingly attractive as a branch of meteorological inquiry, and the soundings of the ocean of air, to use Mr. Rotch's expression, may be held to include observations at high-level stations, records obtained from instruments carried by kites or unmanned balloons, as well as observations made by travellers in free balloons. Of these the last mentioned offer most attractions for the adventurous, and they form an essential part of scientific inquiry, because eye observations can be taken of clouds and other atmospheric phenomena from a point of view not otherwise attainable, and experiments that throw light upon the working of various instruments can be carried out under conditions which cannot be exactly imitated on the earth's surface. For meteorological purposes the usefulness of a free balloon is, however, to a certain extent limited by the fact that the balloon is an aërostat; it is carried with the stratum of air supporting it and the only motion relative to the atmosphere is a vertical one. Wind as understood at the surface is therefore beyond the scope of observation of the balloonist, and all meteorological observations that are dependent upon the motion of air are not primarily suitable for the car of a balloon, where the air is calm and still even in a rapidly moving atmosphere.

The traveller can in clear weather estimate the rate at which he is borne along by noting the places over which he passes, and he can obtain permanent records of his voyages by photographs taken from his car, which suggest a curious reminiscence of old-fashioned maps. A photographic camera is indeed the first and most natural item in the equipment of a balloonist, whether the aim of his voyage be scientific inquiry or merely adventure. One of the most novel and successful departments of the Paris exhibition of 1900 was the aëronautical section, which gave full opportunity for the display of the powers of aërial navigation. During the exhibition fourteen competitions were held, in which a hundred and fifty-six ascents were made. The competitions were of four kinds; for altitude, for duration of voyage, for distance and for descent at a specified spot. The competitors were exclusively French; the greatest height reached was 8417 metres, the longest voyage in time lasted 35·45 hours and covered also the longest distance, namely, 1925 kilometres; the nearest approach to a given point was within 400 metres, after a voyage of 32 kilometres. Of the 156 voyages, 137 were completed within France, ten extended to Germany, three to Belgium and three to Holland, while three were not terminated until the Russian frontier was passed. It is satisfactory to note that all were conducted without accident either to aëronaut or spectator. Among the many interesting photographs obtained during these expeditions is one of the neighbourhood of the Panthéon, Paris, taken from a height of 500 metres and reproduced (Fig. 1) from an article by

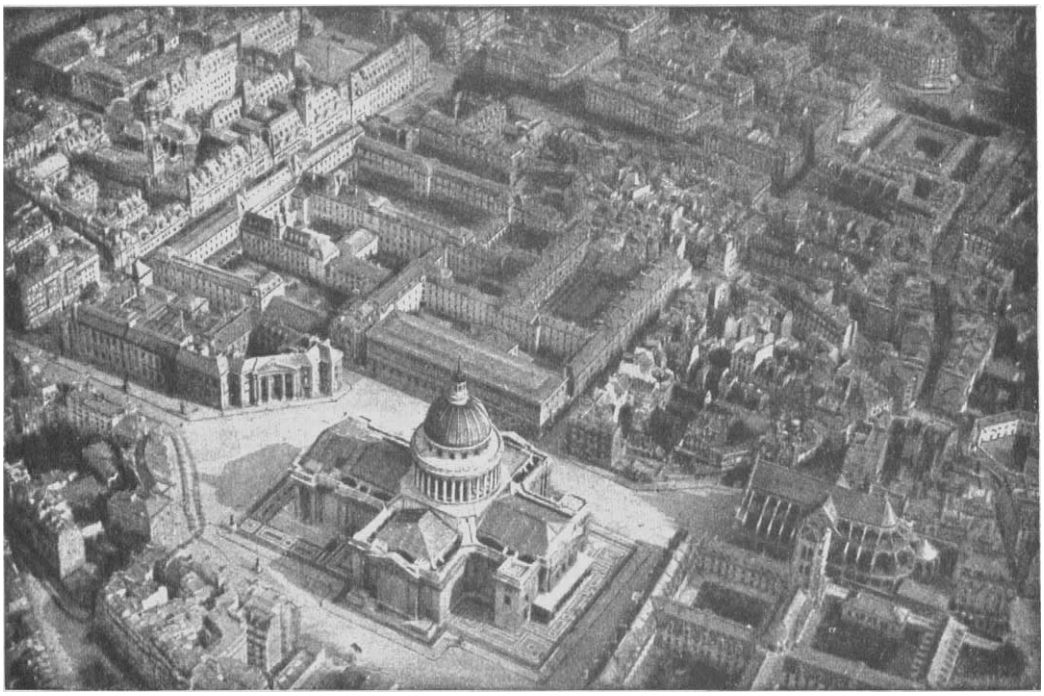

FIG. 1.—Neighbourhood of the Panthéon, Paris, photographed from an altitude of 500 metres.

Commandant Renard in the *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale. For the purpose of comparison, a photograph of Berlin from a height of 2000 metres, taken in 1893 on one of the voyages of the ill-fated balloon *Humboldt*, is also reproduced (Fig. 2). It shows the Belle Alliance Platz in the centre, but the scale is evidently very small. A slightly larger view (Fig. 3) of the central portion, taken on another occasion, is here reproduced from the frontispiece of Prof. Assmann's memoir, "Die Modernen Methoden zur Erforschung der Atmosphäre mittels des Luft-ballons und Drachen," which appeared in the March and April numbers of *Himmel und Erde* last year.

Among the best known establishments for exploring the upper air are those of M. Teisserenc de Bort at Trappes for "ballon sondes" and kites and Mr. Lawrence Rotch for kites at Blue Hill, Massachusetts; but the general use of balloons for scientific purposes has been carried out most effectively at Berlin. By means of funds supplied

by the Emperor William, a very complete establishment for the exploration of the upper air has been installed there. The first balloon acquired was the *Humboldt*, which made its first voyage on March 1, 1893. It was fired by

FIG. 2.—South-west Berlin (Belle Alliance Platz), photographed from an altitude of 2000 metres.

an electric spark and destroyed on landing after its sixth voyage. Through the Emperor's generosity it was replaced by the *Phönix*. Prof. Assmann, in the work already referred to, gives some particulars of the arrangements and results, but the subject is more fully dealt with in a work consisting of three handsome volumes published last autumn and entitled "Wissenschaftliche Luftfahrten ausgeführt vom Deutschen Verein zur Förderung der Luftschiffahrt in Berlin" (Braunschweig: F. Vieweg und Sohn). This contains the account of seventy-five voyages and a number of flights of unmanned balloons, together with the material collected in the course of the expeditions, maps of the regions traversed and a volume of results. The meteorological interest of these voyages is very great, but the work is too elaborate for brief summary. A single example may give some idea of the possibilities of investigation of this kind. On July 6, 1894, the *Phönix* started from Berlin at 6.32 p.m. and travelled north-west to Jutland in nineteen hours; the unmanned balloon *Cirrus* was started at the same time from the same place and was carried by an upper current to Bosnia.

The primary meteorological question to be determined by balloon ascents is the rate of variation of temperature with height. For some time after Glaisher's celebrated voyage of 1862, which concluded his balloon work, the matter was regarded as settled. The Berlin work has reopened it on the ground that the thermometers used by Glaisher were not sufficiently ventilated or screened from radiation. Glaisher was aware of the necessity for precautions, although he discarded special apparatus for ventilation, and his immense experience in the use of thermometers might enable him to obtain results, as, for example, with Daniell's hygrometer, where others of less skill and experience would fail. In the balloon investigations by Berson, Assmann's ventilation thermometer, with special mounting to avoid the car's interference, was used, and every precaution was taken to make the circumstances otherwise comparable with those under which Glaisher made his memorable ascent from the Crystal Palace. M. Berson carried these precautions even to the length of making an ascent from the Crystal Palace itself on September 15, 1898, while a simultaneous ascent was made at Berlin; to make sure that the observed differences were not due to climatic differences between the air over Germany and over England. The day was remarkably hot in England, the temperature being 10° C. above that of Berlin, but the zero isotherm was found within a few hundred metres of 6000 metres at each station. Further trial was made by reproducing Glaisher's arrangement from his description and comparing its readings with the Berlin arrangements. The results were only accepted as conclusive after careful consideration of all the measurements of temperature obtained from the numerous flights of manned and unmanned balloons. In the end Berson was satisfied that the difference of the observations was to be laid to the account of instrumental errors in Glaisher's observations.

The comparison of Glaisher's and Berson's results for the rate of fall of temperature with height, as given by Assmann, is as follows:—

Height in metres.	Rate of fall in Centigrade degrees per thousand metres.	
	Glaisher.	Berson.
0-1000	7·5	5·0
1000-2000	6·5	5·0
2000-3000	5·0	5·4
3000-4000	4·2	5·3
4000-5000	3·8	6·4
5000-6000	3·2	6·9
6000-7000	3·0	6·6
7000-8000	2·0	7·0
8000-9000	1·8	9·0

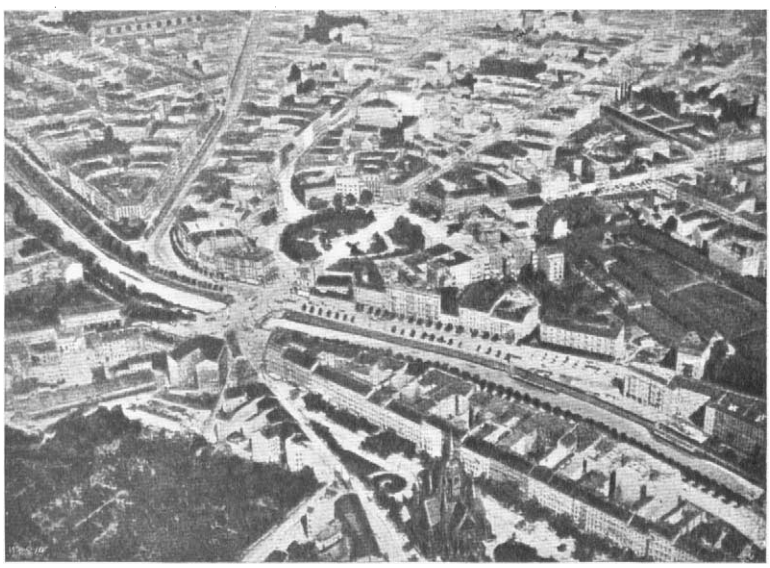

FIG. 3.—Neighbourhood of the Belle Alliance Platz, Berlin, photographed from a balloon.

It will be noticed that whereas Glaisher's observations lead to the conclusion that a constant temperature is indicated at no very great height, Berson's numbers show increasing rate of fall with height, so that the difference

in the results is one of fundamental importance. Berson's numbers clearly do not go to the end of the matter, for with a little play of the imagination in the region of extrapolation, his results bring absolute zero within sight at the very moderate height of some thirty miles, whereas −68° C. is the lowest temperature recorded in the flight of the unmanned balloon *Cirrus* from Berlin, which is reported to have reached a height of 18,000 metres. This, by a curious coincidence, is identical with the lowest temperature recorded at the earth's surface. It was registered at Werchojansk, in Siberia, on January 15, 1885; a still lower temperature, −70° C., is given in the *Meteorologische Zeitschrift* for June as registered by the apparatus of an unmanned balloon started from Vienna on January 10 of last year. Kite observations also afford information as to the rate of fall of temperature under varied meteorological conditions. But the height which they can attain does not give them a final voice in the determination of the question of the lowest limit of atmospheric temperature.

Another quantity for the determination of which balloon observations are specially appropriate is the constant of solar radiation, but the results are not yet final and the subject is too wide for this occasion.

It would be a matter for congratulation if Glaisher's exploration of the upper air could be continued by his own countrymen. Investigations have, indeed, been made recently by the Rev. J. M. Bacon, and, under the auspices of the Aëro Club, by the Hon. C. S. Rolls. But for the use of balloons on any considerable scale these islands are not very suitable. It will hardly yet be forgotten that some years ago an attempt to pursue scientific investigation in this manner resulted in the loss of a valuable life. Work with kites even is not without its dangers, but it is satisfactory to note that the Royal Meteorological Society has taken up this mode of investigating the upper atmosphere, and has not only moved the British Association to devote a sum of money for the purpose, but has secured the active interest of the president of the Society, Mr. W. H. Dines, in the undertaking. The British Isles occupy such an exceptional position with regard to the passage of weather changes from the Atlantic Ocean that the results of a properly directed inquiry of this character can scarcely fail to throw important light on many meteorological questions.

One of the results of the Congress of Meteorologists at Paris in 1900 was an international arrangement for the simultaneous exploration of the upper air in the various countries of Europe by means of unmanned balloons carrying self-recording instruments. An ascent was to be made on a fixed day in the first week of each month. Prof. Hergesell, of Strassburg, chairman of the Aëronautical Committee of the International Conference, undertook the collection and the working out of the results. The ascents have been regularly carried out and brief reports have appeared in the *Meteorologische Zeitschrift*. In this country Mr. P. Y. Alexander, of Bath, has carried out ascents of unmanned balloons on some of the appointed days, and has made provision for observations in manned balloons by Mr. Spencer. With the balloon observations are associated observations of clouds. We have no system of systematic measurement of cloud movements, but in connection with the balloon ascents the following observatories have furnished eye observations of the form and motion of clouds on the days of the ascents and the preceding and following days, viz. Greenwich, Kew, Oxford, Bidston, Stonyhurst, Rousden, Falmouth, Glasgow, Aberdeen and Valencia. The returns have been sent to the Meteorological Office to be forwarded to Prof. Hergesell. The details of the ascents of November 8, 1900 (the tenth of the whole series of international ascents) have already been published, and they show in a very effective manner the initial increase of temperature with height in the region of the anticyclone which covered the continental stations, Paris, Strassburg, Berlin, Vienna and St. Petersburg, at which ascents took place. Inversions of temperature are also very marked in the discussion of the Vienna observations for the ascent of January 10 by J. Valentin in the *Meteorologische Zeitschrift* for June.

For meteorological purposes balloons will be much more serviceable when the means for converting them from aërostats into airships are perfected. It is fifteen years since Commandant Renard, who with his brother has been so active in all that concerns military ballooning in France, published his lecture, "Sur la Navigation Aérienne," before the Société de Secours des Amis des Sciences, in which he lays down with true French clearness the dynamical conditions for the airship as distinguished from the aërostat. The publication is illustrated with a picture of an airship corresponding very closely with those of the airship of M. Santos Dumont that have attracted so much public attention within the last few months. At present airships are at best fair-weather vessels, and fair weather is a dull subject for meteorologists. W. N. SHAW.

GUN-SIGHTS FOR LARGE AND SMALL ORDNANCE.

UP to quite recent times but little has been done by those interested in gunnery to improve in a really practical way the method of aiming either a rifle or gun. The usual method of aiming is much the same as that employed long ago in using the mediæval crossbow. The object aimed at, the fore-sight and the back-sight, are brought into line by the eye of the marksman, always with this defect, viz., that the eye is out of focus with respect to two of the points mentioned when focussed on the third. We know well that, if we fix our attention on a distant object, our eye will automatically focus itself on that distant object; and only an indistinct image of the foresight will be present. Again, should we focus the eye on the fore-sight, then the object aimed at will not be clearly seen. This is also true in an accentuated manner with respect to the back-sight, since it is nearer to the eye than the fore-sight. The operation of thus aiming, even in the best circumstances of light, is obviously unsatisfactory.

The gun-sight problem has been attacked by several leading experimentalists, and in the majority of cases some apparatus in which lenses are employed has been used. An early form of optical gun-sight consisted of a small telescope attached to the gun, the telescope being furnished with an eye-piece and cross-lines or webs, similar to those used in the surveyor's level or theodolite. This telescope is attached to the rifle by a joint at one end, the other end being raised or depressed to suit the range by means of a milled headed micrometer screw. The telescope-sight has been applied to field and other guns, and to it has been added an inclinometer, so that an angle inclination either above or below the horizontal line can be given to the gun.

Objections have been raised to the telescope-sight, and it has been urged that the field is limited, so that it is not easy to "pick up" the object to be hit, and that the object appears to be moving with a speed greater than its real one, also that when heavy charges of gunpowder are used, and the recoil is considerable, there is a risk of the eye of the marksman being injured by the cap of the eye-piece when it is driven back, and also that the adjustment of the telescope may be thrown out, by the concussion on firing the piece. With respect to the first objection, in the case of a man with short sight, the telescope-sight is of great use since it enables him to see the object as clearly as a man with normal vision. When the telescopic method is used for laying field guns, the